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AUTHOR Colbeck, Carol L.; Cabrera, Alberto F.; Marine, Robert J.
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ABSTRACT

Motivational Systems Theory (MST; M. Ford, 1992) was used as a framework to investigate how varying motivational patterns influence faculty members use of teaching practices in their undergraduate classes. Researchers compared the factors associated with faculty members assigning students to work in groups to solve ill-defined design problems with their use of traditional lecture and textbook problem set assignments. The study hypothesized that faculty members use of teaching practices is a function of their backgrounds, training, experiences, teaching goals, beliefs in their own skills, and their perceptions of the extent to which their organizations provide adequate rewards and resources for teaching. The total sample for the analysis, 426, represented 61% of the population of tenured and tenure-track engineering faculty at 3 universities. Participants completed a seven-section instrument that gathered information about teaching practices and beliefs. Findings indicate that faculty members own goals for teaching and beliefs about their own professional skills are strongly associated with the extent to which they use traditional teaching practices or group design projects. (Contains 1 figure, 6 tables, and 29 references.) (SLD)

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Faculty Motivation to Use Alternative Teaching Methods

C. Colbeck

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Carol L. Colbeck
Co-PI for Evaluation, ECSEL
Associate Professor and Senior Research Associate
Center for the Study of Higher Education
400 Rackley Building
The Pennsylvania State University
University Park, PA 16802
clc15@psu.edu

Alberto F. Cabrera
Professor of Educational Administration
Wisconsin Center for the Advancement of Postsecondary Education
The University of Wisconsin, Madison

Robert J. Marine
Assistant Professor and Director of Medical Education Research
Department of Anesthesiology, College of Medicine
The Pennsylvania State University

Paper presented at the annual meeting of the
American Educational Research Association in New Orleans, LA, April 1, 2002.

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Faculty Motivation to Use Alternative Teaching Methods

Carol L. Colbeck, Alberto F. Cabrera, Robert J. Marine

ABSTRACT

We used Motivational Systems Theory (MST) (Ford, 1992) as a framework to investigate how varying motivational patterns influence faculty members' use of teaching practices in their undergraduate classes. Specifically, we compared the factors associated with faculty members assigning students to work in groups to solve ill-defined design problems with their use of traditional lecture and textbook problem set assignments. Our study hypothesizes that faculty members' use of teaching practices is a function of their backgrounds, training, experiences, teaching goals, beliefs in their own skills, and their perceptions of the extent to which their organizations provide adequate rewards and resources for teaching. Our findings indicate that faculty members' own goals for teaching and beliefs about their own professional skills are strongly associated with the extent to which they use traditional teaching practices or group design projects.

INTRODUCTION

There are two important links between academic departments, faculty, and competent college and university graduates. The first is the link between faculty teaching and student learning. Previous research has shown that the effectiveness of various teaching methods varies depending on desired learning outcomes. Lecture may be as good or better than other pedagogical methods for fostering immediate factual recall of material (Kulik & Kulik, 1979, McKeachie, 1990). Currently, more than three-fourths of faculty rely on lecture as their primary teaching practice (Finkelstein, Seal, & Schuster, 1998). Increasingly, however, administrators, scholars, and potential employers of college graduates are calling for faculty to engage students in active and collaborative projects that will prepare them for team-based problem-solving in the workforce (Barr & Tagg, 1995, Black, 1994). Discussion and assigning group work and real-world problems are more effective than lectures and textbook problem sets for developing students' critical thinking skills, interpersonal skills, and professional confidence (McKeachie, 1990; Johnson, Johnson, & Smith, 1998; Cabrera, Colbeck, & Terenzini, 2001; Colbeck, Cabrera, & Terenzini, 2000).

The second link, between the context of academic programs and faculty members' motivation to use the teaching practices that foster desired student learning is not well understood. Much has been conjectured, however, about what motivates faculty to teach the way they do. Many faculty developers assert that most faculty receive little formal training in teaching; instead they rely on informal training achieved by observing their own professors, reading about teaching, discussions with colleagues, or occasional formal instructional development workshops (Weimer & Lenze, 1991). Scholars have also considered organizational reasons why faculty might change their teaching methods

(Bess, 1997). Only a few empirical studies, however, have used some variant of motivation theory to explain either the time faculty allocate to teaching (Blackburn and Lawrence, 1995) or whether faculty use active teaching methods (Einarson, 2001). The study we present here uses an integrative theory of motivation to investigate the personal and organizational factors that influence the extent to which faculty use lecture or collaborative learning practices in their undergraduate classes.

CONCEPTUAL FRAMEWORK

The conceptual framework adopted for this study is depicted in Figure 1 and hypothesizes that faculty members' use of certain teaching practices is a function of their demographic characteristics, experience, and motivation. Motivation, as defined in Motivation Systems Theory (MST) by Ford (1992), involves personal goals (in this case, for teaching), capability beliefs (perceptions of one's own skills), and context beliefs (perceptions of whether or not one's environment provides needed support.)

Motivational Systems Theory, which provides the theoretical foundation for this study, (Ford, 1992), integrates many theories of motivation. MST is grounded in the premise that motivation provides the psychological basis for individuals' development of competence. The theory focuses on three basic components of motivational patterns, personal goals, personal agency beliefs, and emotional arousal processes. *Personal Goals* anticipate desired future outcomes and prepare an individual to try to produce the outcomes (Locke and Latham, 1990). *Personal Agency Beliefs* are an individual's thoughts which relate a goal to the likely consequence if the individual pursues the goal.. Personal agency beliefs are composed of the pattern of two belief processes: beliefs about capabilities and beliefs about support from the environmental context. Capability beliefs, similar to Bandura's (1986) "self-efficacy expectations" or Deci's (1980) "perceived competence," are evaluations of whether one has the skills to attain a goal. Context beliefs, similar to Gurin and Brim's (1984) "perceived contingency" and Weisz and Stipek's (1982) "system responsiveness," are evaluations of whether one's environment will support goal attainment, and involve congruency of personal goals with organizational goals (Maehr & Braskamp, 1986), perceptions of availability of resources, and perceptions of social support and reward. Goals and personal agency beliefs set the stage for the third component, emotional arousal. *Emotions* are subjective states that reveal the degree of success, problems, or failure an individual anticipates in relation to a goal. Emotions become most salient when immediate, vigorous action is required. a desired consequences of motivation is *achievement,* the attainment of a personally or socially valued goal within a specific context. According to Ford, (1992, p. 124):

Achievement/Competence = Motivation (Goals x Emotions x Capability Beliefs x Context Beliefs)

Because the focus of this study was on faculty members' sustained use of teaching methods rather than on transitory actions, the conceptual framework incorporated only personal goals for teaching, capability beliefs, and context beliefs. In addition, previous empirical research on faculty motivation for teaching has shown that

faculty members' socio-demographic characteristics (Einarson, 2001) influence their use of active learning methods and that faculty members' early career history has a modest influence on some faculty members' allocation of time to teaching (Blackburn and Lawrence, 1995). For this study, then, major concepts are defined as follows.

Faculty members' demographic characteristics that may affect their use of different teaching methods include rank, gender, and ethnicity. When comparing faculty with seven years or less of experience with their senior colleagues, Finkelstein, Seal, and Schuster (1998) found little difference in the teaching practices used by the two cohorts. Other researchers have found that women faculty are more likely to use active and collaborative teaching methods than male faculty (Fairweather, 1997, Stratham, Richardson, and Cook, 1991). According to Einarson (2000), research about ethnic differences in use of teaching methods is mixed.

Experiences inside and outside academe may influence the extent to which faculty use alternative teaching practices. Prior qualitative research with engineering faculty involved in curricular reform efforts suggests that those who had prior experience working full-time in industry understand the importance of teamwork in the workplace more than faculty whose primary work experience is teaching and research (Colbeck, in press.) Participation in curricular reform efforts and success in securing funding to support such efforts are also likely to be associated with the teaching practices associated with the reform. Typically, scholarly productivity is considered to involve publications solely related to basic or applied research. For this study, we hypothesized that publications teaching -- about the scholarship of teaching (Boyer, 1990) -- would be positively associated with use of group and design projects, but that publications focused on research would have a negative association with such teaching practices

Goals for teaching comprise the first set of motivation variables included in this study. Previous research about factors associated with teaching have focused on faculty members' interest in teaching (Blackburn, et al, 1991) or satisfaction with teaching assignment (Einarson, 2000, 2001). Motivation Systems Theory (Ford, 2002), however, asserts that goals are critical because they represent both the consequences an individual is trying to achieve and because they direct the processes the individual uses to produce the consequences. Ford explores the nature of several types of goals, including *integrative goals*, which are directed toward promoting or maintaining the well-being of other people. This construct applies well to faculty members' goals for the concepts, values, and skills they hope students will learn in their classes. Because this study was conducted with engineering faculty the individual items we used to operationalize teaching goals were primarily derived from a list of competencies recently established by ABET (2001), the accrediting agency for engineering. Given our focus on use of group projects as well as traditional teaching practices, we also added items concerned with communication and sensitivity to the needs of diverse students.

Individuals may have goals, but see them as unattainable if they do not have the personal ability to achieve them. Another section of the conceptual framework, therefore, considers faculty members' *capability beliefs*, their assessment of their own

skills. Blackburn and Lawrence (1995) also considered the impact of self-efficacy on teaching effort, but operationalized self-efficacy in general terms, such as "teaches effectively" and "works skillfully with students." For this study, we developed items that describe specific skills likely to be associated with teaching with traditional methods or by assigning group/design projects, such as "I give well-organized, informative presentations," or " I work well in a group," or "I am good at identifying and redefining ill-defined problems."

Even if one has the necessary skills, it may be difficult to attain one's goals if the environmental context is not supportive or has inadequate resources. Our conceptual framework, considers two aspects of faculty members' *context beliefs*: likely rewards for teaching, and perceived adequacy of resources for teaching. Faculty members' perceptions of the likelihoold they will receive organizational rewards may directly or indirectly encourage faculty to particpate in some activities and discourage their participation in others (Levin, 1991). Resources are "material factors that can facilitate or impede task performance" (Martin, Schemmerhorn, & Larsen, 1989, p. 190). Faculty members' perceptions of the accessibility, quality and quantity of staff, facilities, and training resources are likely to influence their opportunities to try alternative teaching methods (Peters & O'Connor, 1980).

METHODS

To examine the relative impact of faculty members' demographic characteristics, experience, personal goals, capability beliefs, and context beliefs on their use of traditional teaching practices and their use of group design projects, we developed a questionnaire to be completed by tenured and tenure-track faculty. We administered the survey during Spring, 2000 to faculty in engineering schools where substantial efforts had been under way for ten years to encourage faculty to use teamwork and design projects when teaching undergraduates.

Participating schools were members of coalition funded by the National Science Foundation between 1990 and 2000 to introduce design into their undergraduate engineering curricula and to increase recruitment and retention of women and underrepresented minorities. Member schools of Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL) included City College of New York, Morgan State University, Pennsylvania State University, the University of Maryland, the University of Washington, MIT, and Howard University. The researchers were members of a team responsible for evaluating ECSEL's teaching, curricular reform, and diversity efforts. All of the engineering faculty at five schools received an email invitation to participate that was linked to a password-protected WEB-based survey. All of the engineering faculty at Howard University and only ECSEL participants at MIT received a hard copy invitation and paper version of the survey with a stamped return envelope.

In this paper, we present the results from the three large public university engineering schools (Penn State and the Universities of Maryland and Washington)

where the survey was distributed electronically to all tenured and tenure-track engineering faculty (N = 698). A total of 490 completed surveys were returned from engineering faculty at the three universities, for a response rate of 70.2 percent. We did not use 64 surveys for this analysis, either because the respondents did not have a tenure-track appointment or because they did not teach an undergraduate class during the academic year 1999-2000. Therefore, the total sample for this analysis is 426, or 61 percent of the population of tenured and tenure-track engineering faculty at the three universities.

The instrument included seven sections which asked about (1) faculty members' demographic characteristics, (2) experiences in industry and academe, (3) teaching goals, (4) own skills, (5) perceptions of departmental rewards for teaching, (6) beliefs about the adequacy of resources for teaching, and (7) the teaching practices used in undergraduate classes during the 1999-2000 academic year.

Principal components factor analysis of individual survey items yielded five sets of extremely clean factors corresponding with MST. The factor sets include teaching goals (four factors), capability beliefs about faculty members' own skills (three factors), context beliefs about likely rewards for teaching (two factors) and adequacy of resources for teaching (four factors). The fifth set of factors yielded the dependent variables for teaching practices. The results of the factor analyses for the faculty from all seven schools, including factor loadings and reliabilities are reported in Colbeck, Cabrera, and Marine (2001). We used ordinary least squares multiple regression to estimate the relative contributions of demographic characteristics, experiences, and motivation to faculty members' use of traditional methods or group design projects. The variables were entered in three steps, with demographics first, experiences second, and motivation variables entered last. This order follows the conceptual background predicting the use of teaching practices. The motivation variable set was comprised of the teaching goals, capability beliefs (skills), and context beliefs (likely rewards and adequate resources) factors. We ran two OLS regressions, one for each alternative teaching practice (traditional or group design projects.)

This study was conducted within a single field, engineering. Although this limits generalizability of findings to larger populations of faculty, the study results, nevertheless, have important implications for general higher education practice. Accrediting and funding agencies have focused attention and resources on engineering education reform for the past decade (see, for example, ABET 2000). Therefore, lessons learned from engineering may well be applied to other professional fields and perhaps to arts and sciences disciplines. This study was also limited by its focus on faculty teaching in large public research universities. Although we had data from smaller schools, including historically Black universities, the response rate from those schools was too small to make generalizations, even to the population of engineering faculty at those schools. Therefore, future studies using this model should be conducted across a larger sample of institutions as well as disciplines.

RESULTS

Descriptive statistics for demographic and experience variables are reported in Table 1. Demographic characteristics taken into account for this study included rank, gender, and ethnicity. Nearly one-half the respondents held the rank of full professor. An overwhelming majority were white and male, which is not surprising in the field of engineering. We did note, however, that several respondents chose not to record their gender (4.7 percent) or race (8.7 percent).

Insert Table 1 about here

Respondents had a rich array of experiences in engineering practice, teaching reform, funded research, and publication. Half the respondents had worked full time outside academe as practicing engineers. Almost 40 percent of respondents indicated that they had participated in ECSEL reform efforts in some way. Evaluators had previously determined that across the seven member schools, about one-fourth of the faculty in ECSEL schools had participated in the coalition's reform efforts (Colbeck, in press). Therefore, ECSEL participants are probably over-represented among respondents relative to their proportion in the population of engineering faculty at these three universities. Involvement in curricular reform and teaching innovation was more widespread than ECSEL participation, since nearly 70 percent of the respondents indicated they had received funding in the prior five years for curricular development, teaching innovation, or engineering education research from at least one source. The funding these faculty had received for such purposes, however, was 5 percent or less of the total funding they had received since 1995. More than 90 percent of respondents had received funding from one or more sources in the prior five years for basic or applied engineering research. Not surprisingly, respondents had also published far more about basic or applied research than about engineering education research. Nearly 80 percent had published at least one article about engineering research in the prior two years, but less than 20 percent had published at least one article about engineering education in the same time period.

Insert Table 2 about here

The items comprising the teaching goals and capability beliefs factors and their means are shown in Table 2. On average, respondents from the three large public engineering schools respondents considered the goal of teaching fundamentals more important (mean = 3.17) than goals of teaching for professional development (mean = 2.89), design (mean = 2.82), or teamwork and lifelong learning (mean = 2.59). (The scale ranged from 1 to 4, where 1 = "not important" and 4 = "extremely important.") Respondents had overall high capability beliefs, considering formal communication skills (mean = 3.12), interpersonal communication skills (mean = 2.94), and ill-defined problem solving skills (mean = 2.89) all "very characteristic" of them. (The scale ranged from 1 to 4, where 1 = "not at all characteristic" and 4 = "extremely characteristic.")

Insert Tables 3 and 4 about here

Context beliefs include perceived rewards and perceived adequacy of resources. Items comprising these factors along with factor means are shown in Table 3. Respondents believed that securing grants and publishing articles in leading journals -- whether for education or research -- would be more likely to earn them professional rewards (mean = 3.15) than designing or redesigning a course or including group or design projects in their undergraduate courses (mean = 2.47). (The scale ranged from 1 to 5, where 1 = "very negative" and 5 = "very positive.") In general, respondents perceived that resources available for undergraduate teaching were less than adequate. They perceived, however, that library and AV support (mean = 2.79) and computer and laboratory support (mean = 2.63) were more adequate than either faculty development (mean = 2.11) or administrative and clerical support (mean = 2.01). (The scale ranged from 0 to 4, where 0 = "not available, 1 = inadequate," and 4 = "outstanding.")

As shown in Table 4, faculty respondents used traditional methods more often (mean = 3.13) than group and design projects (mean = 2.47) when teaching their undergraduates in 1999-2000. (The scale ranged from 1 to 4, where 1 = "rarely" and 4 = "almost always.") The use of alternative teaching practices was not mutually exclusive. The correlation between use of traditional teaching practices and use of group and design projects was significant ($p < .001$), negative, and small (-.222).

Two Ordinary Least Squares (OLS) regressions analyzed the effects of faculty members' demographic characteristics, experience, teaching goals, skills, and context beliefs on their use of group/design projects or traditional teaching practices. As hown in Table 5, the regression models explained 28.7 percent and 29.0 percent, respectively, of the variance in faculty members' use of group/design projects or traditional teaching practices. Motivational variables accounted for most of this explained variance. Teaching goals, capability beliefs, and context beliefs contributed to 20.9 percent and 18.6 percent of the variance of gains in use of group and design projects and traditional teaching methods respectively. All regression equations were significant at the $p < .001$ level.

Insert Table 5 about here

Demographic, experience, and motivation variables significantly associated with faculty members' use of the two different teaching practices present an interesting contrast as shown in Table 6. Rank and ethnicity were each significantly related to one teaching practice. Senior faculty were more likely than junior faculty to use group and design projects; on the other hand, rank made no difference in the use of traditional methods. Ethnicity was not a predictor of the use of group/design projects, yet non-white faculty were less likely than white faculty to use traditional methods. The proportion of women faculty in engineering is very small in the population and in this sample; perhaps the proportion is too small to ascertain gender differences statistically.

Full-time engineering experience outside academe, participation in curricular reform, and success securing funding for curricular reform were related to use of teaching

practices. Experience as a practicing engineer positively was positively related with the use of traditional methods. This finding contradicts findings from earlier qualitative studies of faculty at ECSEL schools (Colbeck, in press). On the other hand, the finding that faculty who had participated in ECSEL education reform efforts were more likely than those who had not to teach using group and design projects was consistent with prior ECSEL studies. Similarly, receiving funding for curricular development or teaching innovation was negatively associated with use of lecture and textbook problem sets.

The motivation variables, including teaching goals, capability beliefs, and context beliefs about adequacy of teaching resources, had contrasting effects on use of alternative teaching practices. Two teaching goals were inversely associated with the teaching practices under consideration. The goal of teaching teamwork and lifelong learning was positively related with teaching actively and collaboratively, but negatively related with using traditional methods. In contrast, the goal of teaching engineering science fundamentals was positively associated with the use of traditional methods and negatively associated with the goal of teaching teamwork and lifelong learning. Neither the goal of teaching design nor the goal of teaching professional development had significant associations with the two alternative teaching practices.

Two capability beliefs were significantly related with use of traditional methods and the third was significantly associated with the use of group and design projects. Confidence in one's own interpersonal skills was positively related with the use of group and design projects, activities that require helping students to develop their own abilities to relate effectively with team members. In contrast, confidence in one's own formal presentation skills, including abilities to explain abstract concepts and to give effective presentations, was associated with the use of lecture and textbook problem sets. Furthermore, lack of confidence in one's ability to identity, define, and solve ill-defined problems was associated with the use of traditional methods.

The effects of faculty members' beliefs about their contexts were interesting for what was NOT as well as for what was significantly associated with teaching practices. Faculty members' perceptions of the likelihood they would receive rewards for course innovation (including group or design projects) or for grants or publications had no significant effects on their use of either group and design projects or traditional teaching practices. Beliefs about the adequacy of administrative and clerical resources, however, had significant but contrasting significant relationships with teaching practices: a negative association with the use of group and design projects, but a positive association with the use of traditional teaching methods. The faculty who use group and design projects more may need more practical support than those who rely on lecture and textbook problem sets. Finally, perceived adequacy of computer and laboratory support was positively related with the use of group and design projects.

DISCUSSION

The results of this study have important implications for future research about faculty motivation and for practitioners interested in ways to improve undergraduate

teaching. Motivation Systems Theory (Ford, 1992) provided stronger explanatory power than previous models used to examine the personal and organizational factors that contribute to engineering faculty members' use of different teaching practices (Blackburn & Lawrence, 1995; Einarson, 2001). The combination of motivation variables for goals, context beliefs, and context beliefs explained approximately one-fifth of the variance in respondents' use of traditional lecture and textbook problem sets and in their use of group and design projects in their undergraduate classes. The explanatory power of the model may lie in two reasons. First, it is grounded in an integrative theory of motivation. Second, the concepts were operationalized with items that were specific and relevant to faculty members' daily experience. While this study focused exclusively on engineering faculty in research universities, the model shows great promise for improving understanding of the factors associated with use of teaching practices by faculty in other disciplines and at other types of institutions.

Faculty developers, academic administrators, and others who wish to encourage faculty to use teaching practices other than lecture may draw several hopeful implications for practice from the findings from this study. Previous studies have concluded that little can be done to modify faculty interests, hiring is a critical time to ensure individual fit with the institution (Blackburn, et al, 1991). In contrast, the results of this study suggest three areas to motivate faculty to use alternative teaching methods, even after they have tenure: goals, resources, and skill development. According to Ford (1992, p. 208), when individuals "think about goals in ways that elevate current concerns to the status of specific intentions" they are more likely to commit to those goals behaviorally. This process can be facilitated "by organizing the context so that it clearly affords certain goals" (Ford, 1992, p. 208). In the field of engineering, ABET, the accrediting agency, is organizing the context so that new goals for teaching are becoming salient for engineering administrators and faculty.

Using alternative teaching methods such as group and design projects requires different resources than delivering lectures and assigning textbook problem sets. The findings from this study suggest that the computer and laboratory resources faculty already use for their research come in handy when they also involve students in the process of solving ill-defined problems. Findings also suggest that this type of teaching, however, requires more administrative and clerical support than faculty need for delivering lectures. While further research is needed to determine exactly what kind of support faculty would find most helpful, that research may well be done on a department by department basis. It is quite possible that departments and colleges can provide specific clerical and administrative resources at a minimum cost to facilitate faculty members' active and collaborative teaching efforts.

Those preparing future faculty as well as faculty developers and academic administrators should pay particular attention to the third area: faculty members' beliefs about their own skills. The findings suggest that faculty use teaching methods that are consistent with their perceptions of their own skill strengths. All of the skill sets included in this model, however, -- ill-defined problem solving, formal communication, and interpersonal communication -- are essential for effective performance of faculty

members' research role as well as their teaching role. These findings suggest, therefore, that future and current faculty development efforts focus on fostering interpersonal communication skills and ill-defined problem solving skills. Such efforts may well provide additional benefits. Faculty particpation in administrative service may improve as more become adept at interpersonal communication. Faculty members' research may improve as they gain confidence in identifying, redefining, and solving ill-defined problems.

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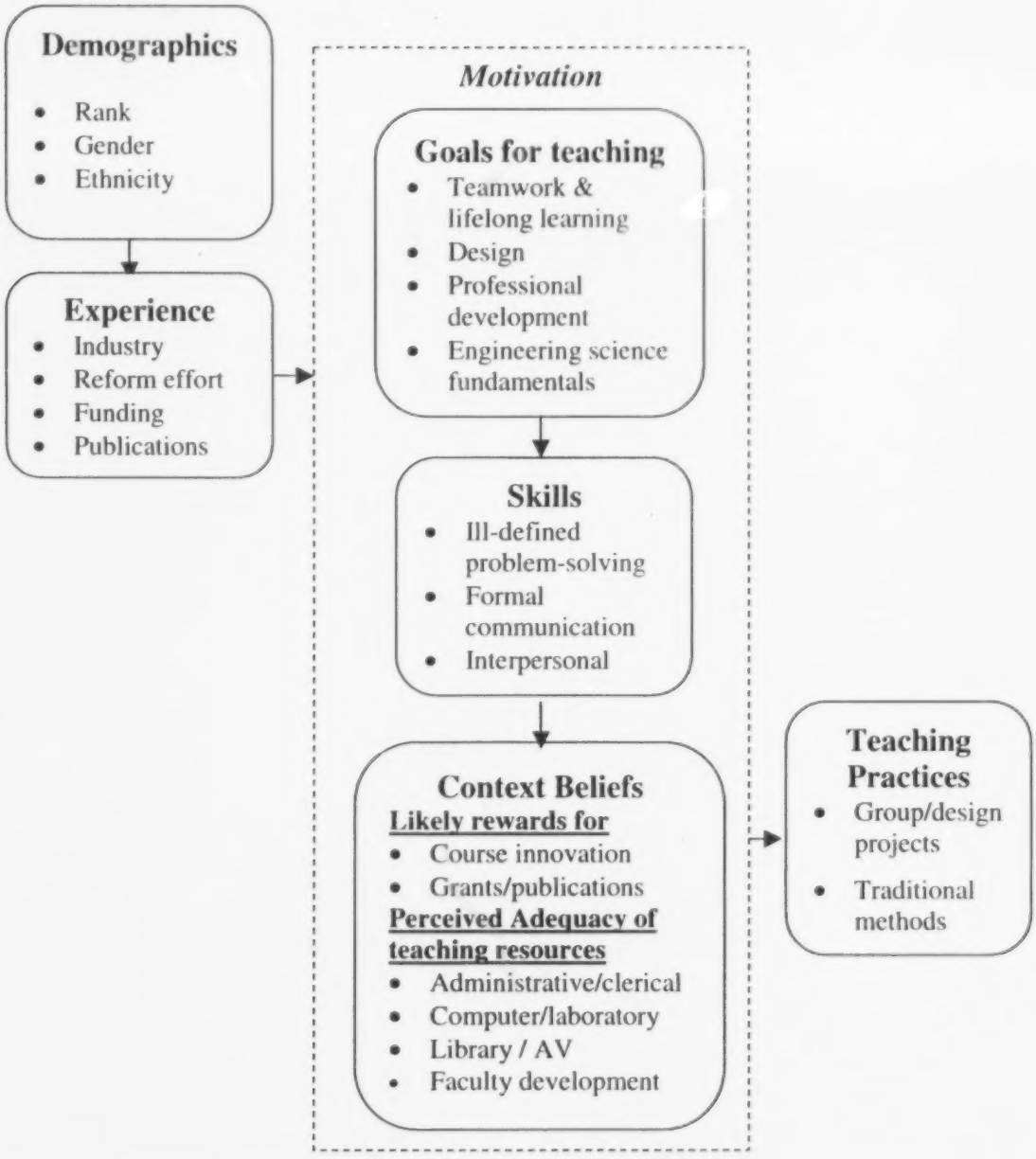

Figure 1: Faculty Motivation to Use Alternative Teaching Practices

Table 1: Demographics and Experience Variables: Frequencies and Percent of Total (N = 426)

Variable	N	%	Variable	N	%
Institution			**Rank**		
Penn State	193	45.3	Assistant professor	98	23.0
University of Maryland	114	26.8	Associate professor	127	29.8
University of Washington	119	27.7	Full professor	201	47.2
Ethnicity			**Gender**		
White	314	73.7	Male	383	89.9
Non-white	75	17.6	Female	23	5.4
Did not answer	37	8.7	Did not answer	20	4.7
Worked full time as engineer	220	49.3	**Participated in curricular reform**		
No	216	50.7	No	260	61.0
Yes			Yes	166	39.0
# funding sources for curricular development or teaching innovation			**# funding sources for basic or applied engineering research**		
no sources	136	31.9	no sources	39	9.2
1 source	126	29.6	1 source	104	24.4
2 sources	97	22.8	2 sources	105	24.6
3 sources	51	12.0	3 sources	123	28.9
4 or more sources	16	3.8	4 or more sources	55	12.9
Publications about engineering education			**Publications about basic or applied engineering research**		
No publications	343	80.5	No publications	86	20.2
1 or more publications	83	19.5	1-2 publications	80	18.8
			3-4 publications	62	14.6
			5-6 publications	74	17.4
			7-9 publications	47	11.0
			10 or more publications	77	18.1

Table 2. Teaching Goals and Capability Beliefs Factors

Scale	Values	Items
Teaching Goals		*Importance that undergraduate students learn from you:*
Teamwork & lifelong learning	Range = 1-4[1] Mean = 2.59	how to function of multidisciplinary teams how to resolve conflicts in groups sensitivity to needs, viewpoints of students from different ethnic backgrounds sensitivity to needs & viewpoints of students from other gender importance of lifelong learning broad understanding of contemporary issues
Design	Range = 1-4[a] Mean = 2.82	how to conduct and design experiments how to design a process, system, or component how to identify and formulate open-ended engineering problems how to solve open-ended engineering problems how to analyze and interpret data
Professional development	Range = 1-4[a] Mean = 2.89	to understand engineers' professional responsibilities to understand engineers' ethical responsibilities to understand the impact of engineering solutions in societal & global contexts
Engineering science fundamentals	Range = 1-4[a] Mean = 3.17	to understand and apply mathematics concepts to understand and apply basic science concepts to understand and apply engineering science
Capability Beliefs		
Ill-defined problem solving	Range = 1-4[2] Mean = 2.89	I am good at identifying and redefining ill-defined problems I design effective solutions to ill-defined engineering problems I am good at creating models, prototypes, or graphic representations of engineering problems
Formal communication	Range = 1-4[b] Mean = 3.12	I explain abstract concepts and principles effectively I write well I give well-organized, informative conference presentations
Interpersonal communication	Range = 1-4[b] Mean = 2.94	I have strong interpersonal communication skills I work well in a group

[1] 1 = Not important, 2 = Somewhat important, 3 = Very important, 4 = extremely important

[2] 1 = Not at all characteristic, 2 = Somewhat characteristic, 3 = Very characteristic, 4 = Extremely characteristic

Table 3. Context Beliefs Factors --
Perceptions of Likely Rewards & Adequacy of Resources

Scale	Values	Items
Likely Rewards		*Likely effect of activity on your professional rewards if you:*
Course innovation	Range = 1-5[3] Mean = 2.47	designed or redesigned a course used group projects in my undergraduate classes used design projects in my undergraduate classes
Grants & publications	Range = 1-5[c] Mean = 3.16	received $100,000 in external funding for curriculum development, teaching innovation or education research received $100,000 in external funding for basic or applied engineering research published an article in a leading engineering research journal published an article in a leading engineering education journal
Perceived Adequacy of Resources		*Adequacy of the following resources in your college of engineering for teaching undergraduate classes:*
Administrative & clerical support	Range = 0-4[4] Mean = 2.01	clerical support release time travel money industry contacts
Computer & laboratory support	Range = 0-4[d] Mean = 2.63	computer hardware computer software laboratory facilities
Library & AV support	Range = 0-4[d] Mean = 2.79	library resources audio/visual equipment
Faculty development	Range = 0-4[d] Mean = 2.11	faculty development professional support

[3] 1 = Very negative, 2 = Negative, 3 = Not applicable, 4 = Positive, 5 = Very positive
[4] 0 = Not available, 1 = Inadequate, 2 = Barely adequate, 3 = Adequate, 4 = Outstanding

Table 4. Teaching Practices Factors

Scale	Values	Items
		Teaching practices used in undergraduate courses in 1999-2000
Group/design projects	Range = 1-4[5] Mean = 2.47	used design projects used group projects used student presentations
Traditional methods	Range = 1-4[5] Mean = 3.12	used lecture used textbook-based problem sets

[5] 1 = Rarely, 2 = Sometimes, 3 = Often, 4 = Almost always

Table 5: Relative Impact of Demographic, Experience, and Motivation Variables on Faculty Use of Group/Design Projects or Traditional Teaching Practices

	Group/Design Projects		Traditional Teaching Practices	
Variable Set	**R^2**	**Change R^2**	**R^2**	**Change R^2**
Demographics	.023	.023	.017	.017
Experience	.078	.055	.104	.087
Motivation	.287	.209	.290	.186

Table 6: Variables Associated with Alternative Teaching Practices

	Group/Design Projects (β)	Traditional Methods (β)
Demographics		
Rank	.114*	.069
Gender (male = 0)	.007	-.026
Ethnicity (white = 0)	.078	-.149**
Experience		
Full-time as practicing engineer	-.032	.197**
Participation in curricular reform effort (ECSEL)	.161**	-.018
% total funding for curricular / teaching reform	.012	-.154**
# funding sources for curricular/teaching reform	-.092	.079
# funding sources for basic / applied research	-.074	-.019
Publications about engineering education (2 yrs)	.078	.087
Publications about basic / applied research (2 yrs)	.034	.085
Motivation		
Teaching Goals		
Teamwork & lifelong learning	.301***	-.187**
Design	.017	.040
Professional development	.014	.077
Engineering science fundamentals	-.115*	.257***
Capability Beliefs		
Ill-defined problem solving	.081	-.235***
Formal communication	-.009	.230***
Interpersonal communication	.167**	.033
Context Beliefs		
Perceived rewards		
For course innovations	-.023	-.056
For grants & publications	-.023	-.077
Adequacy of teaching resources		
Administrative & clerical	-.132*	.120*
Computer & laboratory	.157**	-.022
Library & audio/visual	.025	-.063
Faculty development	-.097	.005
R^2	.287	.290
Adjusted R^2	.234	.239
F	5.416***	5.621***

*p<.05, **p<.01, ***p<.001